CHAPTER 7

WELL SINKING

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9.1 General

Well sinking shall be proposed for Wetwell, in water logged conditions or water table near FGL.

9.2 Earthwork in Excavation

The earthwork shall be in accordance with chapter 3. The safety measures to be taken for excavations for open foundations shall be as per guidance laid down in IS 3764.

9.3 Well Sinking

The Construction and sinking of well shall in general follow provisions of IRC 78-2014- Section VII – Foundations and substructure. The latest editions of this code of practice including all applicable official amendments and revision shall be followed. In case of discrepancy between this specification and that referred in code, the specifications will govern.

Setting Out

Necessary reference points shall be fixed, away from the zone of blow-ups or possible settlements resulting from well sinking operations. These reference points shall be connected to the permanent stations with the base line on the banks. The centre of the individual wells shall be marked with reference to these stations.

Equipment

The following equipments are generally used for the work

(a) Crane with grab buckets - capacity 0.5 to 2.0 cum
(b) Chisels of appropriate sizes
(c) Aqua header for cutting rocky strata
(d) Diving helmets and accessories
(e) Equipment for concrete production, transportation, placing & compaction

Cutting Edge

The mild steel cutting edge shall be made from structural steel section with weight not less than 40 kg/m length and properly anchored into the well curb. The parts of the cutting edge shall be erected on level, firm

ground. Temporary support shall be provided to facilitate the erection and maintenance of the assembly in its true shape. The fabrication may be carried out in the shop or at site. Steel sections shall not be heated and forced into shape. However, “V” cuts may be made in the horizontal portion, uniformly throughout the length, to facilitate cold bending. After bending such ‘V’ cuts should be closed by welding. Joints in the lengths of structural sections, unless otherwise specified shall be fillet welded using single cover plate to ensure the requisite strength of the original section. The cutting edge must be suitably stiffened using plate stiffeners spaced at not more than 1.5m c/c along the periphery of cutting edge. The adequacy of the strength and the efficiency of performance of cutting-edge shall be specifically checked by the Contractor and necessary alterations made if required at his own responsibility. The weight of stiffeners shall not be considered in the weight of the cutting edge.

Well Curb

Well curb shall be of cast-in-situ concrete. The outer face of the curb shall be vertical. The bottom ends of vertical bond rods of steining shall be fixed securely to the cutting edge with check nuts or by welds. The form work on the outer face of the curb may be removed within 24 hrs after concreting. The formwork of the inner face shall be removed after 72 hrs. All the concreting in the well curb shall be done in one continuous operation. The curbs should be cast truly in position, and if construction of any cofferdam is required, it shall be done by the Contractor at his own cost.

9.4 Well Steining

The dimensions, shape, concrete strength and reinforcements of the well shall strictly conform to those shown in the drawings. The form work shall preferably be of M.S. sheets shaped and stiffened suitably. In case timber forms are used, they shall be lined with plywood or M.S. sheets.

Steining built in the first lift above the well curb shall not be more than 2 meters. For stability, the first lift of steining shall be cast only after partially sinking the curb. Concreting of steining may be carried out in subsequent lifts of about 2 meters. Attempts should be made to minimise the number of construction joints. The construction joint details shall be as shown in the drawing, and the receiving surfaces of the construction joint shall be thoroughly cleaned and prepared using air and water jets before the next lift is poured. The concreting layers shall be limited to about 450 mm restricting the free fall of concrete to not more than 2 m. Laitance formed at the top surface of a lift shall be removed to expose coarse aggregates before setting of concrete at the proposed construction joint. To the extent possible, construction joints shall not be located at the site of laps in the vertical steining bars.

The steining of the well shall be built in one straight line from bottom to top such that if the well is tilted, the next lift of steining will be aligned in the direction of the tilt. The work will be checked carefully with the aid of straight edges of lengths approved by the Engineer. Plumb bob or spirit level shall not be used for alignment. After the sinking of a stage is complete, any damaged portions of the steining at the top of the previous stage shall be properly repaired before constructing the next stage.

The height of steining shall be calibrated by making at least four gauges (preferably in direction along centre line of bridge and in a direction normal to the centre line of bridge) distributed equally on the outer periphery of the well each in the form of a 100 mm wide strip painted (preferably red colour) on the well, with every half a meter mark shown in black paint (mark thickness shall be 5mm). The gauges shall start with zero at the bottom of the cutting edge. Marking of the gauges shall be done carefully with a steel tape.

After reaching the founding level, the well steining shall be inspected to check for any damage or cracks. The Engineer will direct and the Contractor shall execute the remedial measures before acceptance of the well steining. If the well cannot be accepted despite any remedial measures, it shall be rejected.

Sinking of well should not be started till the steining has cured for at least 48 hours. The curing of well shall be continued upto 14 days from the day of concreting. Curing can be achieved through the use of water or through any approved curing compound.

Any honeycombed portion and leakage observed in the steining shall be repaired at the Contractor’s own cost to the satisfaction of the Engineer.

Bottom Plug

The concrete mix shall be designed (in dry condition) to attain the concrete strength as mentioned in drawing, and shall contain 10% more cement content than that required for the same mix placed dry, to cater for under water concreting. However, the total cement content shall not be less than 360 kg/cum of concrete with a slump in the range of 150 mm to 200 mm. Admixture may be added to concrete to impart the required strength. The water cement ratio shall not exceed 0.5 and the slump of concrete shall be minimum 150mm. The diameter of tremie pipe shall not be less than 200 mm.

Concrete for the bottom plug shall be laid by Tremie pipe method. Tremie concrete once started shall be continued without interruption for full concreting in the bottom plug. Before commencing plugging, all loose

material from the bottom of the well shall be removed and the inside faces cleaned thoroughly.

Concreting shall be done in one continuous operation till the dredge hole is filled upto the required height and thereafter sounding shall be taken to ensure that the concrete has been laid to the required height.

Least disturbance shall be caused to the water inside the well while laying concrete in the bottom plug and concrete shall not be disturbed in any way for atleast 14 days. To check any rise in the level of bottom plug, soundings should be taken at the close of concreting and once every day for the subsequent 3 days.

The soundness of bottom plug should be tested by de-watering the well by 5 meters below the surrounding water level and checking the rise of water. The rate of rise shall preferably be less than 10 cm/h. In case the rate is higher, remedial measures as directed by the Engineer should be taken by the Contractor at his own cost. The depth of the sump below the cutting for bottom plugging shall be 1/6th the diameter of the well. The Contractor shall take permission from Engineer before commencing the bottom plug. All necessary inspections like study of strata at the founding level, tilt, shift, etc. shall be communicated to the Engineer before bottom plugging. If any leakage of water is found, then necessary grouting of the plug and the junction of the well to control the same shall be carried out by the Contractor at no extra cost.

Sand Filling

Sand filling should be commenced after 14 days of laying the bottom plug. The height of bottom plug shall be rectified before starting sand filling. The sand should be clean and free from earth, clay, clods, roots, boulders, shingles etc. and should be backfilled in layers and consolidated by flooding.

Well Cap

The form work for the well cap should be prepared conforming to the shape of the well cap; concreting should be carried out in dry conditions. The bond rods of steining shall be properly anchored into the well cap.

9.5 Sinking of Well

Generally, the cutting edge is fabricated and connected to the concrete well curb. On top of the well curb, adequate height of well steining is cast and the process of sinking is carried out. After a portion of the well has been sunk, another height of well steining is cast on top of the previous

section and further sinking carried out. The process is continued until the bottom level of the cutting edge reaches the foundation level.

The sinking of the well with use of kentledge shall be commenced only after the steining has been cured for at least 48 hrs. The well should not be placed in a pre-dredged hole. The sinking of the well shall be facilitated by excavating material uniformly from inside the dredge hole. Use of water jetting & divers may be adopted for sinking of well through harder strata with prior approval of the Engineer. The de-watering of well should not be used as a means for sinking of well. Contractor should take necessary precautions to avoid sand blows and he should be prepared at any point of time to tackle the sand blow problem, in case of any occurrence at no extra cost.

In the process of normal sinking any suitable method other than pneumatic sinking as necessary may be adopted. However, no claim due to any confirmations such as boulders, logs of trees met with during sinking or due to any other difficulty experienced in this process shall be entertained. The method to be adopted for sinking of well shall be approved by Engineer. For any change in method of sinking the Contractor shall obtain written permission from the Engineer-in-charge. During the operation of sinking of wells, the strata penetrated through and the behaviour of the well shall be reported to the Engineer. The Engineer's decision on any matter pertaining to sinking shall be final and binding on the Contractor.

As the dredging is in progress, soil samples for the study of soil parameters should be collected for every meter depth and the sample should be preserved as per the standard approved practice by the Contractor at no extra cost. The depth of sump in well at any level should not be more than one metre. Further the depth of sinking of well for a particular stage shall be restricted to 1 metre to avoid the sudden sinking of well i.e., jumping of well. A record of depth of dredging from the original bed level should be maintained right from the commencement of sinking of well.

If the well is sunk beyond the specified founding level without prior approval from the Engineer for any reason, the Contractor will not be entitled to any additional costs. In the event that the top of the well exceeds the required level due to unavoidable circumstances, it shall be the Contractor's responsibility to dismantle that portion of the work at their own cost. However, the matter should be discussed with the Engineer before any work in this regard is carried out.

Sinking History

The sinking history of well should be maintained in the format given in Appendix 1200/I of “Ministry of Road Transport & Highways - Roads & Bridges”.

Use of Kentledge as Sinking Load

Kentledge shall be placed in an orderly and safe manner on the loading platform, ensuring it does not interfere with the excavation of material from inside the dredge hole and does not damage the steining of the well in any way. When tilts are present or there is a danger of well developing a tilt, the position of the load shall be regulated in such a manner as to provide greater sinking effort on the higher side of well.

Use of Divers

Use of divers may be made both for sinking purpose like removal of obstruction, excavation etc and for inspection. All safety precautions shall be taken as per applicable safety code for sinking with divers or any statutory regulations in force. Only persons trained for the diving operation shall be employed and shall be certified to be fit for diving by an approved doctor.

The diving and other equipment shall be of acceptable standard and certified to this effect by an approved independent agency. Arrangements for an ample supply of low-pressure, clean, cool air shall be ensured through an armored, flexible hose pipe. A standby compressor plant shall be provided in case of breakdown. All expenses incurred in use of divers, precautionary measures to be taken, casualties etc., will be at the Contractor’s risk and own cost.

9.6 Precautions during Sinking

In case wells have to be sunk close to each other and clear distance between them is not greater than the diameter of well; sinking shall be taken up on all wells and they shall be sunk alternatively so that sinking of wells proceeds uniformly. Simultaneous and even dredging shall be carried out in wells in such a manner that the difference in the levels of the sump and cutting edge in the adjacent wells does not exceed half the clear gap between them. Preferably plugging of the wells close to each other can be done together.

Bore chart shall be referred to constantly during sinking for taking adequate care while piercing different types of strata. The type of soil as obtained during the well sinking should be compared with bore chart so as to take prompt decisions.

Before seasonal floods all wells sinking of which is in progress shall be sunk to sufficient depths below the designed scour level. Further they shall be temporarily filled and plugged so that they do not suffer any tilt or shift during the floods. The Contractor can ask for any details related to hydraulics like HFL, LWL, scour depth etc., so as to plan his work suitably.

Any losses incurred due to floods etc., by the Contractor due to improper planning of his work will be under Contractor's responsibility. No extra payment will be entertained in this regard.

All necessary precautions shall be taken against any possible damage to the existing foundations, prior to commencement of dredging from inside the well.

The dredged material shall not be allowed to accumulate over the well. It shall be dumped on the downstream and spread as far away as possible. In case the river stream flows along one edge of the well being sunk, the dredged material shall not be dumped on the dry side of the bank, but on the side on which the river current flows.

Very deep sump shall not be made below the well curb, as it entails risk of jumping (sudden sinking) of the well. The depth of sump shall be generally limited to $1/6^{th}$ of the outer diameter or 1m which ever is less.

In case a well sinks suddenly with a jerk, the steining of the well shall be examined to the satisfaction of the engineer to see that no damage has occurred to it.

De-watering shall be avoided if sand blows are expected. Any equipment and men working inside the well shall be brought out of the well as soon as there are any indications of a sand blow.

7.6 Tilts and Shifts

The tilt of any well shall not exceed 1 (horizontal) in 80 (vertical), and the shift at the well base shall not exceed 150mm in any resultant direction. Tilt's and shifts shall be carefully checked and recorded in the format given in Appendix 1207. of "Ministry of Road Transport & Highways - Roads & Bridges" regularly during sinking operations. For the purpose of measuring the tilts along the two axes of the bridge, the reduced level of the marks painted on the surface of the steeling of the well shall be taken. For the determination of the shift, the locations of the ends of the two diameters shall be precisely measured along the two axes, about fixed reference points.

The check for the occurrence of tilt should be made every day before the commencement of the work, and the readings/ findings should be properly recorded and maintained. The check for shift shall be done for every 1.5m of sinking of well. These recordings shall also be properly maintained.

Whenever any tilt is noticed, adequate preventive measures like placing eccentric kentledge, pulling, strutting, anchoring or dredging unevenly and depositing dredge material unequally, putting obstacles below cutting edge, water jetting etc. shall be adopted before any further sinking. After

rectification, the dredging shall be uniform, and the dredged material shall be spread out uniformly. A pair of wells close to each other i.e., where clear distance between well is not greater than the diameter of well, they have tendency to come closer while sinking. Timber struts may be introduced in between the stonework of these wells to prevent tilting.

In the event of a well developing tilt or shift beyond the specified permissible values, the Contractor shall have to carry out, at his own cost, suitable remedial measures to the satisfaction of the Engineer, to bring the tilt and shift within the permissible values, as for as practicable.

If the resultant tilt and /or shift of any well exceed the specified permissible values, the well so sunk shall be regarded as not conforming to specification and a sub-standard work. Generally, it should not exceed 1 in 50 and 300 mm respectively. The Engineer in his sole discretion, may consider accepting such a well, provided the calculations for foundation pressure and steining stresses, accounting for the actual tilt and shift furnished by the Contractor show that well is safe. Any remedial measures required to bring the stresses within permissible values (such as increase in the dimension of the well cap, provision of dummy weights on the well cap) shall be carried out by the Contractor without claiming for any extra cost.

In case the Engineer, in his discretion rejects the well, the Contractor shall dismantle the rejected well to the extent directed by Engineer and remove the debris. Further the Contractor shall at his own risk and expense complete the bridge with modifications acceptable to the Engineer. The wells which are not conforming to the specified limits of tilts and shifts, if accepted for one or other reasons will be penalised in the form of lump-sum deductions per meter length of well which will be at the discretion of Engineer.

Seating of Well

The well shall be uniformly seated at the founding strata. After the well has been evenly seated on good hard rock, arrangements shall be made to facilitate proper inspection in dry and visible conditions before the bottom plug is laid. The founding levels shown in the drawings are purely based on the data available from geo-technical investigations. The Engineer on inspection will decide upon any modifications that may be required to meet the structural aspects. The bottom plugging shall be commenced only after this inspection and concurrence from Engineer.

Tolerances for Well Steining and Well Cap

The permissible tolerances are as follow:

(a)	Variation in dimension	:	+ 50mm - 10mm
(b)	Misplacement from specified position	:	15mm

(c) Surface Irregularities measured with 3m straight edge : 5mm

(d) Variation of levels at the top : ± 25mm

Measurement for Payment of Sinking of Well

The depth of sinking shall be measured from the natural bed level to the bottom of the well curb.